AN IMPROVED METHOD OF USING THE TELEGRAPHIC REACTION KEY

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As commonly used, the telegraphic key is not an entirely satisfactory reaction device. In the first place, there is the minor objection that it is not conveniently portable. It cannot be easily and quickly transferred for use in different places. If similar experimental conditions are maintained, the key must always be used at a constant height. Consequently, the table or stand on which it is placed must either be moved with the key, or a new stand of the same height must be provided for a different position of the subject. A more important objection is the fact that the release of the key may be brought about by a variety of possible forms of response. A mere lift of the finger will release the key, but the release may also be made by raising the hand, the forearm, the whole arm, or even by a movement of the body. From the use of the single pair of muscles involved in lifting the finger, the response may spread to the use of various combinations of large sets of muscles. As one set of muscles becomes relatively fatigued in making the reaction movement, another set may be brought into play. The importance of making the reaction movement as simple and uncomplicated as possible and of limiting it always to the same set of muscles needs hardly to be emphasized. Unless such a uniformity of conditions is obtained, the responses in successive reactions may be widely diverse in character. Under such circumstances we have no way of knowing whether a variation in reaction time is due to a change in the mode of response, or to a change in some other conditions influencing the reaction. One is not measuring homologous events.

Experimental analysis by Judd[1] and earlier work by W. G. Smith[2] has shown that the reaction movement with the ordinary use of the telegraphic key may be preceded by a sudden antagonistic movement, as well as various changes in prereaction muscular tension. Judd used a spring-supported key

[1] *Yale Psychological Studies,* I, (N. S.), p. 141.
[2] Mind, XII, (N. S.), p. 47.

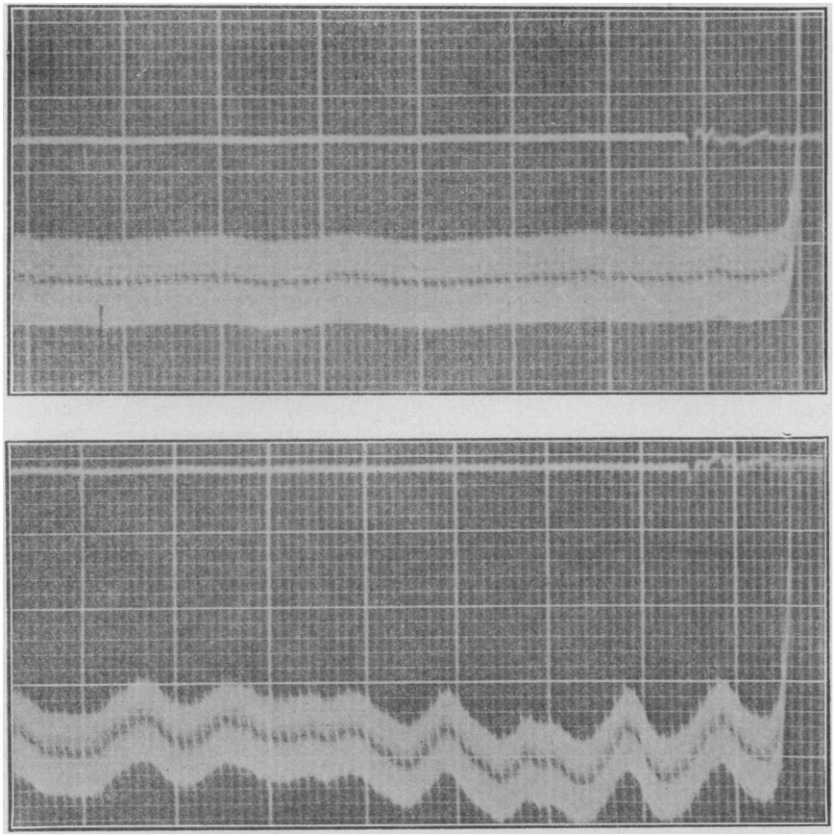
without arm rest. He found, however, that the antagonistic movements could be eliminated by requiring the finger to press upward against a second spring during the period of preparation. Since, as Judd's investigation shows, the reaction time is varied considerably by these antagonistic movements, they should if possible be eliminated.

The use of the telegraphic reaction key as developed in the Wesleyan Laboratory and here presented involves the suspension of the key, as a pendulum instead of on a spring, and employs the opposition of the thumb and fingers in producing the reaction movement. An ordinary telegraphic key mounted on a light wooden base is suspended so as to hang in front of the subject at a height at which the reactions can be most comfortably made. Generally, the same height as the elbow is the most satisfactory. The key is closed by placing the finger on the button and the thumb on the back of the wooden base, and pressing them together. By simply opening thumb and finger, the key is released. In point of view of its suspension and the employment of both thumb and finger, it resembles the modified form of the Dessoir reaction key devised by Scripture,[3] and has all the advantages of portability claimed for the latter. Instead of requiring thumb and finger to open in a vertical plane, as is the case with Scripture's key, the suspended telegraphic reaction key allows a horizontal motion of thumb and finger which is rather more natural and easier. Moreover, in Scripture's key the thumb is held in a relatively fixed position and plays no part in making the response movement. Furthermore, in making the response movement, the finger must move a mass and overcome a variable amount of friction. The suspended telegraphic key allows the thumb to move naturally and freely, and offers no resistance to be overcome by the finger.

With the use of the suspended telegraphic reaction key, the number of muscles which may be used in making the response movement is reduced to the fewest possible, viz., the set of muscles involved in the opposition of thumb and finger. By the use of these muscles and these alone can the key be released. Movements of the wrist, arm, or body cannot replace the reaction movement, nor retard it by an antagonistic movement. By thus confining the response to the action of a single set of muscles, one source of possible variations in reaction time is removed.

[3] *Yale Psychological Studies*, 1893, p. 88. See also Titchener, Experimental Psychology, 1905, II, Part I, p. 165.

FIG. 1



MICRO-PHOTOGRAPHIC RECORDS OF REACTION MOVEMENT SUPERPOSED ON MUSCLE TREMORS. (MAGNIFIED 250 TIMES.)

Another factor to be noted in connection with the use of the suspended telegraphic key is that it apparently eliminates the antagonistic reactive movements described by Judd. Enormously magnified graphic records of the reaction response gave no indication of such movements. In Figure 1 are shown reproductions of photographic records of the muscular changes in thumb and finger, before and during the response. These records were obtained by photographing the optically magnified movements of a fine silk fiber made to move in exact

correspondence with all rapid changes in muscular tension preceding the reaction movement. In taking these records, the regular telegraphic key was replaced by a small rubber bulb, which the subject pressed between thumb and finger and released in exactly the same way as he would the regular key. This bulb was connected by tubing to one end of a closed cylinder, the other end of which was covered by an elastic membrane, making a small Marey tambour. Any changes in the volume of the bulb with consequent changes of pressure in the cylinder would cause the membrane to move back and forth correspondingly. Attached to the membrane was the silk fiber, the movements of which, magnified 250 times by a projection microscope, were photographed by a falling plate camera.[4]

A sharp sound served as the stimulus to which the subject reacted, and the moment of giving the stimulus is shown by the break in the small line at the top of the record. The release of the bulb in the reaction response produced such a large movement of the fiber that it was carried completely off the plate, in spite of a vent to prevent rupture and eliminate slow pressure changes.

The device for transferring changes in pressure between thumb and finger to movements of the silk fiber was one of great delicacy. Relatively large movements of the fiber image resulted from very slight changes in pressure on the bulb. Muscle tremors and variations in muscular tension are conspicuous on the records. The records shown in Figure 1 are samples of two general types of records obtained in the experimental tests. In the upper record, the muscle tremors and changes in muscular tension during the preparatory interval are relatively slight; in the lower record, these variations are more emphasized. The different types were not limited to different subjects. From the same subject we obtained both smooth and wavy records in apparently chance succession.

Not one of our twenty odd records from four subjects shows any reactive antagonistic movement like those found by Judd. Judd finds a satisfactory explanation of the reactive antagonistic movements difficult, and ventures the opinion that they are due to a diffusion of the motor impulse which conditions the response. If such is the case, how are we to explain the disappearance of these movements when the subject reacts against the resistance of a spring, or by opening thumb and finger, as in the use of the suspended telegraphic key? A

[4] For a description of the falling plate camera see Dodge and Benedict, The Psychological Effects of Alcohol, 1915, p. 79.

possible explanation is that the sudden antagonistic movement is the result of a downward thrust of the finger to aid in the movement of the arm upward. Movement of the arm from the elbow means that the muscular contraction has to work against a long leverage. A slight downward push of the finger is certainly a great aid in getting the movement of the arm started, and is a natural mode of response. When, however, the finger is pressing against a resistance from above, any downward movement of the finger cannot aid in overcoming that resistance. Consequently, such a movement, being entirely useless, would be eliminated from the muscular response. It would be interesting to know whether those subjects in Judd's experiments who tended strongly to giving the antagonistic reactive movement did not also predominantly tend to use the arm in making the reaction movement. If such be the explanation of the antagonistic reactive movements as found by Judd, then it is not difficult to explain their disappearance in the use of the suspended telegraphic key, for this entirely eliminates the possibility of that form of response.

Furthermore, both mechanically and biologically, there seems to be no reason why the movement of opening the finger should be preceded by a movement in the opposite direction. But one set of muscles are involved in making the response, and it is hard to conceive how the contraction of a set of muscles would be aided by a preliminary contraction of their antagonistics. The upward movement of the arm, however, is directly aided by a preliminary downward thrust of the finger. Biologically, the opening of the thumb and finger is a natural movement, the movement of releasing something painful and injurious to the organism. It would be contrary to biological precedents if the movement of releasing an injurious object, such as a hot coal, for example, should be preceded by a movement to hold it more firmly. In any event, all the evidence at hand argues against the possibility of the reaction movement being preceded by a sudden antagonistic movement, in the use of the suspended telegraphic key.

The fact that the suspended telegraphic reaction key may be quickly and easily transferred for use wherever desired, requiring only some support for suspension, the fact that it limits the reaction movement to the action of a single set of muscles, and the fact that it eliminates an antagonistic reactive movement from the response combine to make its use an improvement over the reaction key as it is commonly employed.